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GCSE (9–1)

Delivery Guide

DESIGN AND TECHNOLOGY

J310
For first teaching in 2017

Topic Area 5: Material considerations – Timbers

Version 1

Contents

TOPIC AREA 4: MATERIAL CONSIDERATIONS – TIMBERS

Introduction

GCSE (9-1)

DESIGN AND TECHNOLOGY

A guide to approaching the teaching of the content related to Topic Area 5: Material considerations - Timbers

Delivery guides are designed to represent a body of knowledge about teaching a particular topic and contain:

- **Content:** A clear outline of the content covered by the delivery guide;
- **Thinking Conceptually:** Expert guidance on the key concepts involved, common difficulties learners may have, approaches to teaching that can help learners understand these concepts and how this topic links conceptually to other areas of the subject;
- **Thinking Contextually:** A range of suggested teaching activities using a variety of themes so that different activities can be selected which best suit particular classes, learning styles or teaching approaches.

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Link to qualification:

http://www.ocr.org.uk/qualifications/gcse-design-and-technology-j310-from-2017/

Specification content (Sub Topic 1)

Sub Topic 1: Core consideration of timber materials

Exam content

5.1 What are the main categories of materials available to designers when developing design solutions?

Understanding that products are predominantly made from multiple materials.

An overview of the **main categories** of materials as follows:

b. Natural and manufactured timber, including:

- **i.** hardwoods, e.g. oak, birch and teak
- **ii.** softwood, e.g. pine, cedar and spruce
- **iii.** manufactured boards, e.g. MDF, plywood and block board.

NEA content

a. Develop and apply in-depth knowledge by selecting and working with appropriate materials and components when developing their ideas, early models and producing their final prototype(s).

Thinking conceptually

General approaches:

Learners should recognise that very few products are manufactured from just one material, and that the purpose of using multiple materials is that a product will benefit from the properties and characteristics of the individual material choices. In this way, products can be made in such a way that they can outperform products that previously were made with less considered choices of materials. However, they will also recognise that using fewer or even a single material for products makes them exceptionally easy to process at their end-of-life, and that wherever possible, the reduction of materials and methods used to join them will give a final product eco design characteristics.

It is important that all learners are able to understand and identify the different materials choices that exist for timbers, including the main categories of hardwood, softwood and manufactured board. For learners only looking into the core content related to timbers, having knowledge of the different types of timbers and being able to exemplify some materials is all that is required at this point.

Learners looking at this area in depth need far greater specific knowledge and experience of timbers and will also need to be clear about the sourcing of materials, the methods by which they are gathered in both sustainable and unsustainable ways, sawn and seasoned, into their specific stock forms and subsequently processed through planeing and further seasoning for different applications.

Learners will need to also consider:

i) the social, moral, cultural and economic factors behind choices of timber

ii) how changes in fashion, trends, taste and style affect timber choices

iii) the environmental impact of different timbers

iv) the ethical choices between different timbers.

For the NEA, learners will need to use their knowledge of timber properties in order to establish viable testing approaches and make selections for the right timbers in their project, and will therefore need to learn:

i) how to test materials appropriately for the design solution they are developing

ii) how to use results from testing materials to support iterations in the development process

iii) how to choose between materials with similar working and performance properties

iv) which processes would be suitable for the materials being considered?.

Common misconceptions or difficulties learners may have:

Learners should not consider timbers as the first choice material for any new design solution, nor attempt to tackle a design task with timbers in isolation of other materials, but see the consideration of timbers as an opportunity to also combine them with other material families to create composites and multi-material design solutions. The categories of timber include a broad range of different performance properties, and decisions can be made between materials in the same category as easily as they can be made between different categories, and materials from different categories can also be combined for a composite or multi-material product solution.

Learners will also want to consider timbers as a category of materials that are readily accessible and applicable to the design of jigs, tools and templates for the processing of other materials. For example, MDF formers for vacuum forming.

Conceptual links to other areas of the specification – useful ways to approach this topic to set learners up for topics later in the course:

Ideas relating to the processing, sourcing and distribution of timbers will present comparable scenarios for other material groups, such as polymers or papers for example, and do share some similar issues in relation to recycling and end-of-life. Characteristics and the language of material properties will be applicable to other material categories. Learners can also apply the same testing techniques and broader considerations such as culture and society, to other material categories, and might use the same or similar language to describe the impact of material choices.

Learners will need to consider timbers in the same way they consider other materials in the NEA, and base iterative decisions on the modelling, prototyping, testing and reflection process they conduct in the design phase.

Thinking contextually

Using a handling collection of samples

For this activity, learners will be presented with a box full of samples of materials. Based on initial appearance, learners will be asked to organise these into the categories of softwoods, hardwoods and manufactured boards. This can be conducted with either the headings provided or short statements about the properties of each category.

Once organisation of the samples has occurred, learners could have the opportunity to turn samples over to reveal their true identify and category or alternatively Learners could repeat the task, instead organising the material samples by different headings, for example, hardness, flexibility, uniformity, etc. These properties could focus solely on aesthetics or other visual cues or if in a workshop environment, they could be working properties such as: difficult to cut, easy to bend, or hard surface quality.

In varying the headings and the focus of the sorting task, learners can learn about ways in which materials might be categorised with different foci, some relating to aesthetics, some to function. The learners could be provided with more detailed information relating to sourcing, carbon footprint or simple costing, and organise the samples further more by broader factors beyond properties.

Working with samples

This activity is more suited to those wanting in-depth knowledge and understanding. Learners are provided with samples with which they can work, using tools and equipment. Learners are then given the task of manufacturing a part of a product, ideally a part which would be handled. For example, the handle of a walking stick or similar product. Learners will need sufficient workshop experience and knowledge to be able to choose between processes, tools and techniques and given time to change the sample from a simple block into a piece that is more ergonomic and aesthetic. Learners may be encouraged to use finishing techniques such as waxes, varnishes and other surface treatments.

Once learners have created their pieces, the parts could be fitted to an example product and then tested, analysed and critiqued by learners for merit under the headings of:

i) ease of working with the material

ii) aesthetic qualities of the material

iii) ease and impact of finishes applied to the material

iv) functional performance of the material in use.

Learners given the right guidance and opportunities to explore materials in this way. Learners should have the opportunity to build confidence in material processing and finishing, but also gain valuable workshop, prototyping and testing techniques to help in final outcome manufacture.

Handling collection of products

This activity can be differentiated dependent on the level of learning required in this area.

Learners will enjoy the opportunity to handle finished and high quality outcomes as part of a handling collection. In this activity, the focus of the collection is on providing examples, obvious and appropriate, or potential or surprising, for each of the materials in all three categories. The handling collection should include products made of different materials, where the choice of the material being used is clearly purposeful for the product and the selection is related to the properties of the material being used. For example, using beech for a child's toy or teak for an outdoor table.

Learners would be able to analyse, similar to earlier research tasks, the product solution and in this case, analyse and critique the choice of material(s). Their task will be to identify the specific characteristics and properties which were key to the choice of material for this application. Learners will be able to consider alternative materials to the solution, and debate why one material choice superseded another.

Learner Resources – Activities

Title	Summary description	Relevant chapter (i.e. Content, Thinking Conceptually, Thinking Contextually)	Mapping to specification level
Using a handling collection of samples	This activity will require the preparation of samples of all of the materials in each category, labelled with the name and properties underneath each. Learners will need to organise these samples under varying headings provided by the teacher.	Thinking Contextually	5.1b, 5.2a, 5.2b
Working with samples	This activity will require the preparation of samples of all of the materials in each category, cut to a specific size and shape. Learners will be provided a product solution for which they can manufacture a part, which will subsequently be tested for its performance.	Thinking Contextually	5.1b, 5.2a, 5.2b
Handling collection of products	This activity will require the purchase or gathering of a handling collection of products made using the range of materials classified as timbers. Each product will need to be suitable to handle and critique, and learners will be able to use a prompt question sheet to write down their thoughts. At the end of the activity, the reveal by the teacher will allow learners to amend their decisions.	Thinking Contextually	5.1b, 5.2a, 5.2b

Learner Activity

Material Investigation (timbers)

Introduction

In this task, you are going to explore different samples of material and act as an investigator to establish which material is which.

To do this, you will need to:

- judge the material on appearance
- consider the materials physical properties (weight, etc.)
- consider the materials working properties (by cutting them for example)
- consider all other sensory information (e.g. smell).

Once you have established the information on the sample, you will then be challenged to match it up to cards about each material

The activity

Individually or in groups, collect your sample tray.

Take a systematic approach to organising samples, for example, order them by:

- appearance
- weight
- groups such as 'has a grain' or 'has no grain'.

Document your results (photograph etc.)

Next, consider measuring the materials physical properties, for example:

- measure the sample
- weigh the sample.

Now consider the working properties of the sample by:

- bending the sample
- apply force to the sample (tension or compression)
- scratching the sample with a tool (hardness)
- cutting the sample with an appropriate tool.

Record all findings appropriately.

Review your findings as a group and make predictions about what materials are from your existing knowledge.

Now collect the information cards from the teacher for each sample.

Read them, and match them to the materials based on your findings.

How many did you get right? Let the teacher present the results, and award your group a point per correctly identify sample.

Extension activities/questions:

Consider appropriate applications for materials from each sample.

Based only on the properties (working and physical), outline where and how you would use certain materials, and not others.

Specification content (Sub Topic 2)

Sub Topic 2: In-depth consideration of timber materials

Exam content

5.2 What factors are important to consider when selecting appropriate materials and/or system components when designing?

a. The characteristic properties of the main categories of materials (5.1 a–e, not the specific materials) and why this makes them appropriate for different uses, such as:

- density, strength, hardness, durability, strength to weight ratio, stiffness, elasticity, impact resistance, plasticity, corrosive resistance to chemicals and weather, flammability, absorbency, thermal and electrical conductivity.

b. The physical and working properties of specific materials, with consideration of:

i. how easy they are to work with

ii. how well they fulfil the required functions of products in different contexts.

c. Other factors that influence the selection of materials and/or components, including;

i. required functionality of the design solution

ii. aesthetic attributes

iii. environmental considerations

iv. availability and cost of stock forms v. social, cultural and ethical considerations

NEA CONTENT

a. Develop and apply in-depth knowledge by selecting and working with appropriate materials and components when developing their ideas, early models and producing their final prototype(s).

Thinking conceptually

General approaches:

The challenge of this topic is not the ability for learners to know which materials have which properties, but in being able to recognise desirable material properties for different applications. The success of designers is often underpinned by their breadth of experience of designing for different situations, whereas learners will have little of this experience to draw upon.

Beginning to develop a learner's understanding of the characteristic properties of materials before delving further into the uses and advantages/disadvantages of specific materials allows for greater appreciation of material selection. It is important to understand that the characteristic properties are to be understood as generic core content, i.e. the strength and hardness of timbers and their aesthetic qualities etc.

When moving into content 5.2b onwards, we have the opportunity to discover greater depth of the properties and attributes of timbers with those learners covering this area in preparation for the 'in-depth' sections of the exam.

Where learners are developing an understanding of properties such as hardness or strength, it is important to begin with materials that convey very notable and dramatic differences in their performance, rather than materials that have very similar performances under testing. For example, comparing MDF to HDF will draw dramatic difference, whereas scots pine and mahogany will (for certain properties). Learners starting with extremes will support their understanding of both the properties and example materials that convey them.

For learners to develop their knowledge, they will need to learn definition of properties which they can recall at will. For each property, they will need to exemplify it in a material and likely suggest an application for that material that benefits from that property. For example, teak has excellent, weather resistance making it suitable for the application to outdoor furniture.

Where possible, it is important for learners to see, handle and experience different materials, and see through testing these properties under scrutiny. Industry standard testing such as a Vickers or Brinell Hardness Test could be taught alongside a practical application of the test. Supporting videos or hand-outs will support the reinforcement of the learning and share best practice approaches.

Should the teacher decide to provide hands-on making experiences as a way of helping learners to develop an understanding of how easy (or hard) materials are to work with, and then subsequently how they perform for the application, a simple product or system should be designed to:

1. focus learner efforts on experiencing and comparing the working properties of the material
2. allow for the outcome to be tested to prove or disprove this property
3. provide learners with the opportunity to compare and contrast to suitable alternative materials.

In order for learners to appreciate a broader understanding of other factors that relate to material selection, they will need on-going and regular exposure to different materials, their properties and example applications. This can be through example outcomes from projects, handling collections and simple one-off outcomes made for demonstration purposes. Many of these other factors will be taught in more depth as part of other topics from the specification, such as stock forms or environmental considerations, but the properties of materials will be useful as an on-going consideration during all of these topics of study.

Where learners want to access much more specific data and performance characteristics of a broad range of materials, the use of CAD software to simulate different forces will provide excellent links to other areas of study and develop skills applicable to the design process in the NEA.

Once the NEA is underway, it is important that learners are encouraged to constantly test and critique different materials as part of the iteration process, and develop an improved solution to the project not only through changes in design and function, but also through considered material selection.

One aspect of this topic that will influence material selection is also the opportunities to shape and form the materials being selected. Wherever possible, learners should design ideas and select materials based on the data and information available to them, and not make selections based on the limitations of provision in the workshop. For example, a lack of wood lathe should not dissuade the learner from considering materials which are easy to turn, and designing forms which might require turning.

Common misconceptions or difficulties learners may have:

Materials choices should not be based on the limitations of provision in a school environment. Where learners have little access to the broad spectrum of materials, it is important that this does not reflect in the learning and the work conducted in the NEA. Learners must continue to consider all materials in the design process.

Where learners fail to develop a thorough understanding of properties often occurs where materials are not tested as a visual exercise or a tactile experience. Learners will develop a stronger grasp of this topic if they can handle, work with and see test results based on actual materials.

Thinking conceptually

Conceptual links to other areas of the specification – useful ways to approach this topic to set learners up for topics later in the course:

Learners will be able to test and simulate material performance in CAD software once parts have been designed. This will be a powerful link to the topic of material properties, given the ease in which learners can create simulation tests on materials, varying the force, direction of force, and the material being acted upon with ease. Providing the learners with the ability to read and interpret data on CAD simulations will be a useful process for learning this topic.

Product analysis uses a range of similar language and critical thinking that will help learners question how materials perform and under what conditions materials might be selected for use.

The practical nature of the iterative design process from model to finished product will link heavily to this topic and vice versa. This is due to the critique of properties and factors involved in choosing between materials and the hands-on experience of trying out different materials.

Many of the scientific-style testing and evaluating of materials will support the science elements in this specification, including formulating test approaches, making them unbiased, predicting outcomes, conducting a rigorous method of testing and reflecting and understanding the results. Learners will benefit from a repetitive but consistent approach to this.

Thinking contextually

Sample Testing

Learners start by watching a video about a specific test, such as a Vickers test, conducted in a scientific laboratory on a sample of material. Learners will need to understand the language used in the video and why certain actions are taken on the test sample. Learners will benefit from making notes or writing steps of the test down.

A class discussion will help learners to engage with what they have seen and heard and begin to consider the test they will conduct themselves. With this complete, the learners will need a sample of each material they want to test and a rig for testing the sample. For example, a Vickers Test will require a jig to hold a centre punch in place over the sample, and weight to be applied to the centre punch. A Charpy Impact Test could be recreated using a swinging hammer and a vice to hold the sample in place.

Once learners have been shown how to conduct the test, they will be able to do so with the range of samples. This will provide an opportunity for learners to use digital media such as video recording devices to film and replay testing, especially where test videos on a Charpy Impact Test (for example) can be slowed down to review the sample breaking or the end position of the swinging hammer.

Once a range of tests have been conducted on a range of samples, there will be sufficient evidence for learners to reflect and rank the performance of materials under property headings. This is a useful class discussion activity where different groups have conducted the same testing approach.

Creating samples

In order to facilitate the test activity above, learners could engage with a 'make' task where they use hand tools and equipment to cut, shape and form the samples of each material. In this way, they can add the practical working properties of the materials to be tested to their knowledge and experience before committing to a rank order of where these materials compare under different headings.

Use of products in context

In order for learners to develop their experience as outlined previously, they will need to handle and experience materials performing for their given application. This is a good way for learners to see how materials actually work compared to the theory of how they might work. Design solutions which go through repeated use to prove their performance, such as a piece of sports equipment or a piece of furniture, need to be tested and experienced. Learners will not be able to test to destruction any of the solutions due to the risk or injury it could cause, but learners can experience how the materials perform in normal use. For example, learners trying out different hockey stick materials to experience how well they absorb shock, or reduce the vibration when hitting a ball, will give learners a practical experience about a material in use. If a material is chosen to be hard, the opportunity to try to scratch, mark or damage the surface through wear will be a worthwhile activity if the design solution is appropriate to damage in this way.

CAD Simulation

Where CAD software is available, learners can simulate testing on basic parts to critique their performance. Many available packages also provide eco-design tools and the ability to render images for aesthetic critique, providing learners with a quick platform on which they can generate outcomes and data to support material testing. Learners who are able to engage with this process, with respect to available stock forms, will be able to work in ways expected for a high achieving learner.

Case Study contexts

In order for learners to tackle the nature of broader considerations such as social, cultural, ethical and environmental factors, learners will need specific case studies from which to extract information to inform their design judgements and decision making. The more diverse and engaging these case studies of timber-based design solutions are, and how they challenge the learners to think, are important to consider when planning tasks for the teacher to conduct.

Learner Resources – Activities

Title	Web link	Summary description	Mapping to specification level
Vickers Hardness Testing	https://www.youtube.com/watch?v=aSLhYZMZH3A	In this activity, the learners watch a simple Vickers Test being conducted on a material. Learners are challenged with writing a procedure for conducting their own Vickers Test on timber samples, and must predict the potential issues of doing this compared to testing steels (as the video demonstrates).	5.2a
Charpy Impact Test	https://www.youtube.com/watch?v=tpGhqQvftAo	In this activity, the learners watch a simple Charpy Impact Test being conducted on a material. Learners are challenged with writing a procedure for conducting their own Charpy Impact Test on timber samples, and must predict the potential issues of doing this compared to testing steels (as the video demonstrates).	5.2a
Fatigue Test	https://www.youtube.com/watch?v=LhUclxBUV_E	In this activity, the learners watch a simple Fatigue Test being conducted on a material. Learners are challenged with writing a procedure for conducting their own Fatigue Test on timber samples, and must predict the potential issues of doing this compared to testing steels (as the video demonstrates).	5.2a
Compression Test on timber	https://www.youtube.com/watch?v=DFeHYFPElvE https://www.youtube.com/watch?v=yqAFSKlALwk	In this activity, learners watch a Compression Test on timber being conducted and note down the information and outcomes of the testing.	5.2a
Strength and Torsion Test on timber	https://www.youtube.com/watch?v=M14u2xHDTzE https://www.youtube.com/watch?v=mTPYmrCuYnY	In this activity, learners watch a Torsion Test on timber being conducted and note down the information and outcomes of the testing.	5.2a

Learner Activity

Where do I see this property?

Introduction

In this activity, you are challenged with identifying products that present a specific property. You will have a list of properties you need to know, and the task will be to simply identify products that convey this property.

For the material area you are studying, you will need to be able to only name materials from that area of study (for example, timber).

The activity

For the properties below, identify a product and material that demonstrate this property clearly.

1. density
2. strength
3. hardness
4. durability
5. strength to weight ratio
6. stiffness
7. elasticity
8. impact resistance
9. plasticity
10. corrosive resistance to chemicals and weather
11. flammability
12. absorbency
13. thermal and electrical conductivity.

Extension activities/questions:

For each property and material, identify an alternative material that is either:

- better at achieving the desired outcome

or

- worse at achieving the desired outcome.

State how and why you chose these materials.

Can you explain why materials used in this context from history were used?

For example, why did we use oak for wheels on horse carts?

Specification content (Sub Topic 3)

Sub Topic 3: Sources and origins of timber materials

Exam content

5.3 Why is it important to understand the sources or origins of materials and/or system components?

a. The sources and origins of specific materials.

b. An overview of the processes used to extract and/or convert the source material into a workable form.

c. Consideration of the ecological, social and ethical issues associated with processing specific materials to convert them into workable forms, such as:
- mining, harvesting, manufacturing, transporting.

d. The lifecycle of specific materials when used in products.

e. Consideration of recycling, reuse and disposal of specific materials, such as:
- recycling and sustainability schemes
- eco-materials
- upcycling.

NEA CONTENT

a. Develop and apply in-depth knowledge by selecting and working with appropriate materials and components when developing their ideas, early models and producing their final prototype(s).

Thinking conceptually

General approaches:

Learners will recognise that trees provide the source of our timber materials, and this topic will help them to develop a more in-depth knowledge about a broad range of timbers from across the categories of softwoods, hardwoods, and man-made boards. Initially, learners will need to be able to recognise that deciduous trees and coniferous trees are physically different, thriving at different speeds in different climates.

Once able to recognise the differences, learners will be ready to develop knowledge about the different timbers being sourced from different climates: cold, temperate and tropical. The development of globalisation would provide a context for why timbers are now available beyond their local and native climates and help learners recognise potential environmental and economic issues with choosing one timber over another.

Once learners can recognise that timbers do vary considerably in their origin and the physical appearance as a tree, they will need to learn about the harvesting trees, sawing and the process of seasoning for different applications. Subsequent learning about the process of planing will help learners understand this additional process used by suppliers to produce material choices for the customer, and could lead to learners considering finishes such as pressure treating. This will be supported by an introduction to learning about physical characteristics of timbers, from green timber, freshly cut, to seasoned timber, and the changes that occur during this transformation. The properties of timbers will include their varying strengths, the aesthetics, and will broaden to a discussion and analysis of timber defects such as knots. Learners will then be able to appreciate the material as a manufacturer, and consider the working properties of timbers and why these might affect choice.

Once learners fully grasp the ideas behind selecting, sourcing and processing timber, they will be in a suitable position to begin to critique the timber industry, looking at the impacts of logging, sustainably sourcing and forecasting supply, the challenges for areas of deforestation, and the subsequent pollution and destruction of the local environmental balance as timbers are cut, processed and transported away.

UK and national programmes such as The Forest Stewardship Council (FSC) will help learners to recognise the efforts of industry and government to challenge the market for timber, and learners will be able to learn about the potential positive and negative impact of producing and using man-made boards.

As learners become more engaged with the topic and develop their understanding of different man-made boards, their new and engineered properties, and the stock forms for which manufacturers design for, learners will be able to look at social schemes as an alternative to using virgin materials and man-made boards, such as up-cycling or repurposing.

To round up the topic, learners can broaden their learning to look at which materials are currently trending in product design, and create reference image boards that capture the current trends in different product markets from furniture to toys.

Common misconceptions or difficulties learners may have:

Learners will need to be able to recognise and understand the sourcing, physical characteristics and working properties of a range of timbers, but the list of different timbers should not extend too far that it affects the learner's ability to differentiate between species. A broad range of differing hardwoods, softwoods and man-made boards suitable for a wide variety of applications will give learners sufficient knowledge to engage with evaluating suitable materials for new design solutions. A balance should be achieved so that similar materials are not given equal consideration, but be difficult to differentiate by properties and application.

For example, for softwoods, learners might consider: pine, Douglas fir, spruce and cedar, but not larch or poplar.

For hardwoods, learners might consider: beech, ash, teak, oak, mahogany and balsa, but not hickory, elm, maple, walnut, fruitwood, iroko or wenge.

To broaden into alternative timbers in this topic, learners would benefit from considering cork, bamboo and rattan.

For man-made boards, learners might consider: fibreboards, plywoods, blockboards and other appropriate composites of timber.

Conceptual links to other areas of the specification – useful ways to approach this topic to set learners up for topics later in the course:

Learners will benefit from recognising that timbers have inherent strengths and that these can be enhanced in a product solution through consideration of construction and reinforcement. Timbers can often be hard to create CAD simulations for, due to the varied structure of each unique piece of timber and designers can benefit from real testing of the materials to give more accurate performance data to evaluate. As a porous material, timber has the potential to be shaped and formed using heat and moisture, or cold pressed into shape as part of a lamination process, and the potential of what can be achieved with timbers can relate to the thickness of the piece being designed with.

Learners will be able to engage with the concepts of costs, quantities and stock sizes, and use timbers in the classroom as a case study for learning about production costs linked to scales

Thinking conceptually

of manufacture, and provide a template approach for tackling learning about other material areas.

A deep understanding of the material properties of each timber will help learners prepare to learn about the wide range of manufacturing processes, workshop and industrial, which can be employed to shape and form timbers and other materials.

The use of man-made boards in the production of jigs, moulds, formers and templates to support other production processes such as vacuum forming will also be a useful discussion and branch of study.

Learners may lastly consider the work of past and present designers as part of a study of timbers, to identify the current and potential future trends in timber use for product design.

Thinking contextually

Analysing your daily life - recognising timbers

For this activity, learners will need to be able to capture images of their surroundings as part of a visual analysis of their daily routine, with specific focus on identifying different timbers in use.

Learners can be set a specific window of time, and asked to photograph (or simply write down in a diary) all of the instances in which different timbers, softwoods, hardwoods and man-made boards are in application. With a checklist of all of the learnt timbers as a target, learners should look to recognise the aesthetic properties of different timbers first, and capture this with a photograph. Once learners have identified the timber in question, their task is to match the relevant material properties to the application they have photographed. For example, in capturing a plywood in a table, learners will want to decide why plywood has been used in this context. Learners who can develop this task will be able to consider not only what the properties are in the example they find, but recognise also what alternative materials could have been chosen and predict why these were not chosen above the material that was. The photographic diary could form the basis of an analysis of the context of environment for which the learner might design for in their NEA.

Matching properties

For this activity, learners are provided with images of products labelled with their material (from the timbers the learners are considering). The first challenge is to group the product images into timber material categories.

Once groups have been created, learners are challenged to match the working properties and physical characteristics to the groups or individual products. Both properties and characteristics can be shared between different groups.

Where learners are more able to progress from this task, the organisation of descriptive language about properties and characteristics can be refocused on priorities about which are more important for certain applications over others. For example, the property of being 'hard' might be more important to a table top than the aesthetic appearance of featuring a grain. Learners can debate their priorities for each product being analyses, and reordering ranking of properties as the debate becomes more advanced.

Develop a case study about a chosen timber

In this activity, the learners in a class are given a timber each, or one between two if required and given the time and computer access to explore the material in depth. The outcome of the activity would be a presentation board which could, in as few words and sentences as possible, convey the relevant information about the timber to the audience (the rest of the class). Samples of the material surrounded by example applications, sourcing information, properties and other characteristics would form a single display board about the timber. Each timber would be presented and form a display in the classroom, or captured digitally and shared with the class as a revision tool on the topic of timbers.

Recognising future applications of timbers

For this activity, learners are provided with handling collection of timber products, with the specific instruction to consider their future viability for recycling, up-cycling and as an eco-material. To help the learners, the teacher will need to provide examples from different material areas, and challenge the learners to think conceptually about how timbers might be recycled into new products, up-cycled into new uses, or consider the timbers being analysed as potentially eco-materials, and how these might be better exploited through design. As a free design task based on a handling collection, learners would benefit from images of the products to sketch and draw over, or to annotate with their ideas. At the end of the task, learners can conduct a short presentation to the class to convey new ideas for future implications and applications of timbers as a sustainable material.

Learner Resources – Activities

Title	Organisation/ Company	Web link	Summary description	Additional description	Mapping to specification level
Learning about challenging tree harvesting		https://www.youtube.com/watch?v=AQ9OJfaCdwc	What are the challenges of the tree harvesting you see in the video? Consider the information about extreme harvesting and write a short outline of what an easier and safer approach to tree harvesting would look and feel like.		5.3b, 5.3c
Myth or Future Application? Timber Skyscrapers	TED.com	https://www.youtube.com/watch?v=Xi_PD5aZT7Q	Learners are tasked with watching the inspiring TED talk and deciding if the idea of wooden sky scrapers is as crazy as it sounds. At the end of the lesson, learners will be asked to decide if it a feasible idea, and will need to justify why based on what they learnt.		5.3c, 5.3e
Explore materials by application	Trada	https://www.trada.co.uk/techinfo/tsg	Using the Trada search engine, learners can choose an application and property, before searching a database to find the best timber materials suited to that application.	Learners should work through a list of different applications, and note the materials suggested.	5.3a, 5.3b, 5.3d

Specification content (Sub Topic 4)

Sub Topic 4: Available forms of timber materials and components

Exam content

5.4 Why is it important to know the different available forms of specific materials and/or systems components?

a. Awareness of commonly available forms and standard units of measurement of specific materials when calculating costs and quantities, including:

i. Weights and sizes

ii. stock forms, such as:
- lengths, sheets, pellets, reels, rolls, rods.

iii. Standard components, such as:
- timber, e.g. hinges, brackets, screws

NEA CONTENT

a. Develop and apply in-depth knowledge by selecting and working with appropriate materials and components when developing their ideas, early models and producing their final prototype(s).

Thinking conceptually

General approaches:

The aim of this topic is for learners to develop a clear understanding of the stock forms with which they might engage a design task with. Stock forms relative to the timber group will be available to view at local retail outlets, so learners who have been proactive to visit these will have an understanding that timber will not be available in blocks or tubes.

Part of the understanding here is that learners not only recognise that timber is sold in specific forms such as sheets, but that processing by a manufacturer has achieved this form for a specific manufacturing benefit. Learners should, by the end of this topic, be able to identify the form in which timber is sourced, the processing used by the timber logging company to extract the useful material (and also know what happens to the waste at this point), and the benefits this can have on distribution of timber to subsequent customers. The customer, potentially a furniture manufacturer or large scale building contractor, will want their timber in a specific form which learners will need to know. Once this form has been received, it can be processed further (a linked topic to this on processing timbers in the workshop and commercially) into the shapes and forms useful for manufacturing specific products and systems.

A useful overarching focus for this topic is for learners to study the properties of timbers at different stages in the lifecycle from tree to finished product or system. These changing properties form part of the justification for why different parties invest time and capital into changing the material, by seasoning, for example.

To round off this topic, learners should have a list of the stock forms of timbers from different categories, and be able to apply this information to the task of designing. The opportunity to design, and annotate the stock forms, or create sub sketches of this information, will show application and an important milestone in learners being able to effectively design within the parameters of the material stock forms.

For learners to be able to make technical and economic decisions about material choices, including the specific stock forms to use, during the design stage, they will need to have access to cost and dimension data from the material supplier(s) used by the school. This could be in a form accessible to the learners such as a catalogue or online shop.

Learners will lastly benefit from using the same sources of information to establish the broad range of standard and off the shelf components available to them for creating functional features between each component in their design solution. Learners who have access to and understand, possibly by way of example outcomes, the broad range of hinges, fixings, brackets and similar timber related parts will have a stronger ability to design for these in their solutions. Exemplification of the range will be important for learners to not only see the parts in use, but potentially feel and make design judgements about different options.

Common misconceptions or difficulties learners may have:

Timber provides a broad range of choices for stock forms in both softwoods and hardwoods; with a much more specific and bespoke choice available in man-made boards. Learners who simply recognise that timbers can be planks, sheets, rods and veneers will have limited ability to apply this information to well considered design activities.

Where learners have little understanding of why the lifecycle process of tree to finished solution requires numerous processing along the way, there is a tendency for learners to make superficial decisions about choosing materials. Learners may dismiss the environmental impact of timber processing and select hardwoods purely on appearance, or choose a rare breed of timber without consideration given to the cost of the finished solution. A link to this topic is the nature of wasting materials, where waste can be acknowledged as a cost to production and the business.

Learners often dismiss the natural and stock form information of materials because their designing is focused on achieving specific shape and form. Learners who select timbers to create tubular structures or large solid cubes have not achieved the learning aims of this topic. Learners who can justify why these forms are not achievable will be in a better position to design more fluidly.

The limitations of stock forms are also an area which can lead to negative perceptions about the materials and the supply of these. Learners who become frustrated by the lack of choice have not understood the nature of material sourcing, production and distribution. However, learners should be encouraged, where possible, to act in a creative and innovative way in their designing and a balance between using what is available, and pushing to create, new solutions. This will be a positive one if only to demonstrate that the learner recognises the limitations in place, and is able to challenge them in a way that could be feasible.

Conceptual links to other areas of the specification – useful ways to approach this topic to set learners up for topics later in the course:

The opportunity to draft up and learn through a step-by-step or lifecycle approach in this topic means that learners will be able to engage topics such as production planning or Lifecycle Analysis (LCA) in a way that makes links or creates an element of repetition in understanding.

The learning associated with stock forms, including methods to research and cost these, are analytical skills that can be applied in new contexts in the NEA or other material areas.

Thinking conceptually

Learners who have learnt to and can design for stock forms will be able to apply the same approaches to other material groups such as, polymers or metals, while the ability to critically judge and choose standard components associated with these groups will be the same skill simply applied in a different context.

Where learners have had opportunity to look at weight, volume and area calculations, and linked these to costings, this learning will be beneficial in helping learners make economic decisions about the planning for production stage of their NEA project or in analysing existing solutions where the information is available (for example, in a detailed product disassembly activity).

The crossover nature of materials and their processes means that this topic will naturally link and support the learning about processing techniques for timbers and other materials. Learners who learn about the planeing of materials, drying or sawing will have some knowledge about timber processing before they consider the processes available in a workshop environment or in industry.

Where the teacher has taken an active approach to linking changing material properties to each of the stages of the lifecycle of timber sourcing and production of stock materials, learners will have a solid foundation about properties and how these change for different applications. Finally, learners should gain an appreciation of aesthetics for materials, and may be able to use this understanding to help research existing and historical trends in design.

Thinking contextually

In order to deliver this topic successfully, the aim is for learners to be able to design with stock forms clearly in mind. For this to be effectively achieved, learners should be provided with:

- examples of designs using stock form information
- examples of designs that do not consider stock forms
- a framework for assessing design ideas which includes criteria relating to stock form use, material properties, etc.

If this is conveyed to learners early on, and there is an understanding of how stock form information is important to design, they will be better prepared for the learning that will take place.

The learning can then take a number of routes, but a common approach would be to look at creating a storyboard (visual or written) about the sourcing of timber from trees, the sawing and planeing of the material into forms suited for distribution, its seasoning and further processing, and its final distribution to manufacturing centres where products and systems can then be built.

As this storyboard is drawn up, it is useful for learners to sketch what the material looks like as a thumbnail sketch alongside. This can then be annotated with material properties including information like the percentage of water content and functional properties, and coloured or rendered to show aesthetic properties.

Learners will want to know specific examples, such as the sourcing of UK timbers and more exotic hardwoods from abroad. This gives the lesson the opportunity to bring broader areas of learning into the activities, such as environmental and social impact, global sustainability issues and link to topics in the specification that help learners to see the broader picture and the impact on material choice. Learners might benefit from seeing videos about sourcing, using automation using robotics and consider this specific issue in relation to employment and the economics of industry.

The study of man-made boards will need to take place in a slightly different context to softwoods and hardwoods; given that its lifecycle is different and the use of processing is more diverse. Learners could again draw up a step-by-step storyboard, and again use sub-sketches of the material at each stage annotated with changing properties and aesthetics. This would be useful for examples such as chipboard, where processes change the appearance of the material considerably and there will be opportunity for the teacher to introduce learning about surface finishing and CNC machining.

At this point, existing solutions made and available to discuss in the school, such as past pieces of work or purchased products, would also be useful. Learners who can see materials being applied to a 'make' task will start to develop an appreciation of possibilities. At this point, it would also be useful to introduce the concept of standard off-the-shelf parts, and look at these being applied to specific design solutions.

Once learners are fully able to outline the lifecycle of stock form creation, they can use the school's own supplier catalogues and websites to begin to engage with weights, sizes and costings. Stock forms of sheets in feet will need to be calculated into millimetres and vice versa. Thicknesses and terms such as planed or rough cut, etc. will also be key terms that learners' will need definitions for. Learners can use the information at this point to begin to cost and value design solutions. A hands-on activity, similar to a product analysis, is useful here. A method of recording this data, such as a spread sheet with pre-setup calculations of quantity, cost etc. will help learners mimic approaches they will need to evidence in the NEA later.

Once the learning has been rigorously reviewed and learners are actively able to discuss how they can design for stock forms, they can return to the design task set out at the start of the topic. Using the assessment structure, learners can design a specific solution and once completed, swap with their peers for marking. Learners can use the assessment criteria to merit or demerit the designing and sketch or annotate improvements for the learner to take on board. For this design task, learners may need access to the catalogue or data sheets used earlier and should use sub-sketching and annotation to communicate standard parts and details relating to the task.

Where the learning aims have been achieved, the class could progress to another material area with less guidance and apply their skills with less teacher-led activities.

Learner Resources – Activities

Title	Web link	Summary description	Additional description detail
Create a model of an FSC tree nursery	https://www.forestry.gov.uk/pdf/TimberProduction.pdf/$FILE/TimberProduction.pdf	In groups, read the case file from the Forestry Commission, before creating a detailed model, then communicate the design and management of Commission nurseries for developing a timber source.	Learners would use packs of model trees or similar to create models of the stages of the source from the FSC. Different groups could model different stages or scenarios. Groups can present their finished models and present these to the class. Information cards or labels to the model will support later revisiting of the topic for revision.
Step-by-step of timber production	https://www.youtube.com/watch?v=SwxinbpQ9B4	Learners are tasked with writing/drawing the stages of timber production as outlined in this video from How it's made. Learners can annotate these to explain steps in detail.	
Compare old timber production to modern approaches	http://www.core77.com/posts/47932/Aerial-Video-View-of-Hi-Tech-Sawmill-Operations	Learners can watch the video about modern timber production and automation, and compare the strengths and weaknesses of each approach, considering economic, social and environmental impact.	The traditional example can be of the manual approach to tree felling, seasoning and production.

Learner Activity

Analyse the design of equipment for timber production

Introduction

In this task, you are going to act as the CEO of a logging company, and review a new piece of equipment that you are considering investing in.

Your task is to watch the video (https://www.youtube.com/watch?v=PE1f1GydafQ) about the machinery, and identify where you feel your business would benefit from this investment.

- Currently, your business logs trees using workers and chain saws.
- You have 80 workers, and work across a large site throughout the year.
- Your workers occasionally get injured, struggle at times of the year to work because of adverse weather, and are low skilled. They are cost effective to employ, and work locally to your site. Your business needs to expand to meet growing demand, and you are considering your options.

The activity

Review the context and then watch the video.

As a CEO, you are going to make a case for or against investment in new equipment.

Write your case in detail, with clear bullet points for your argument.

Now that you have created your argument, you are going to pitch it to shareholders who will sanction the expenditure.

If you have chosen to not invest, you will need to explain this to the shareholders (teacher).

If you want to invest, you will need to also explain to the shareholders (teacher).

The two sides to this argument to not debate against one another in this instance as bot have shared interest in improving the business, but the shareholders will choose a winner in this instance.

Extension activities/questions:

Research into alternative models for timber production.

Learners can use the internet to look at alternative options to this large scale investment. learners will need to be able to identify the benefits and drawbacks of alternative choices.

The small print

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